Project Title:

Properties of finite systems including nuclei at high temperature and angular momentum (Properties of highly excited nuclei)

Name:
Name:
○Nguyen Dinh Dang (1), Nguyen Quang Hung (2), A.K. Rhine Kumar (3), Le Tan Phuc (4)
Laboratory at RIKEN:
(1) Quantum Hadron Physics

1 - We examine the thermodynamic properties of mass A ~ 200 nuclei utilizing angular momentum gated nuclear level densities (NLDs) extracted in the excitation energy range of 2–15 MeV. Interestingly, the experimental NLDs are in good agreement with the results of a microscopic approach, which is derived based on the exact pairing plus the independent-particle model at finite temperature (EP + IPM), whereas the conventional Hartree–Fock BCS and Hartree–Fock–Bogoliubov plus combinatorial method fail to describe these data. Consequently, the thermodynamic properties of those nuclei at finite angular momentum have been extracted using the EP + IPM NLDs. While the heat capacities of ^{200}Tl, ^{211}Po and ^{212}At (near spherical nuclei) follow the trend as expected in odd–odd and even–odd masses, surprisingly an *S*-shaped heat capacity is found in odd–odd deformed nucleus ^{184}Re. It has been shown that this *S*-shaped heat capacity observed in ^{184}Re is caused by not only the breaking of nucleon Cooper pairs but also the change of pairing induced by deformation.

2 – We have published a review on pairing in excited nuclei, summarizing a subject of almost five-decade research on the thermodynamic properties of pairing in many-body systems including superconductors, metallic nanosized clusters and/or grains, solid-state materials, and focusing on the excited nuclei, that is nuclei at finite temperature and/or angular momentum formed via heavy-ion fusion, α-induced fusion reactions, or inelastic scattering of light particles on heavy targets. Because of the finiteness of the systems, several interesting effects of pairing such as nonvanishing pairing gap, smoothing of superfluid-normal phase transition, first and second order phase transitions, pairing reentrance, etc, will be discussed in detail. Influences of exact and approximate thermal pairing on some nuclear properties such as temperature-dependent width of the giant dipole resonance, total level density, and radiative strength function of the γ-rays emission will be also analyzed. Finally, the first experimental evidence of the pairing reentrance phenomenon in a ^{104}Pd nucleus as well as its solid-state counterpart of ferromagnets under strong magnetic field will be presented.

Usage Report for Fiscal Year 2019

Fiscal Year 2019 List of Publications Resulting from the Use of the supercomputer

1) N. Quang Hung, N. Dinh Dang, and L.G. Moretto
Pairing in excited nuclei: a review
Reports of Progress in Physics 82 (2019) 05630.

2) Balaram Dey, N. Quang Hung, Deepak Pandit, Srijit Bhattacharya, N. Dinh Dang, L.T. Quynh Huong, Debasish Mondal, S. Mukhopadhyay, Surajit Pal, A. De, S.R. Banerjee,
S-shaped heat capacity in an odd-odd deformed nucleus,
Phys. Lett. B 789 (2019) 634.